4. Evolution within the Genus *Dendronephthya* (*Spongodes*) (Alcyonaria), with descriptions of a number of species.

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(Plates I.–III.†; Text-figures 1–30.)

Part I.—General.

§ 1. All who have worked at Alcyonarians will agree as to the difficulties presented by the genus *Dendronephthya* or *Spongodes*. For here we have to deal with a multitude of species within a relatively narrow range. Thus Kükenthal, in his 'Versuch einer Revision der Alcyonarien: II. Die Familie der Nephthyiden, 2. Teil' 1905, deals with no fewer than eighty-seven species; and Henderson, in the 'Alcyonarians of the Indian Ocean,' Part II. 1909, with another series of sixty different from the former. And yet in both cases the species are described in minute detail.

The continual experience in investigating a collection of representatives of this genus is that, in spite of an initial determination to refrain from adding to the already large number of described species, one is forced to do so. And there is no denying that each of these new forms has a distinct individuality. This experience inevitably raises a number of ætiological questions which it may be useful to state, although they cannot be more than partially answered. Some of them at least could be replied to by an investigator in a good locality, having at his command a large number of specimens of any given form.

§ 2. The outstanding phenomena which present themselves are, apart from the multitudinous species, the following:—

A. That the specific distinctions are all of a relatively trivial sort, such as mode of branching, grouping of polyps, length of polyp stalk, strength of supporting bundle, presence or absence of a definite "crown," the number and the arrangement of the spicules in the anthocodial points, the distinction between the cortex of the polyparium and that of the "sterile stalk," and the nature of the spiculation of the canal-walls.

B. That the species differ one from the other to a large extent in the congeries or collocation of such characters as we have mentioned; that is to say, two species with similar anthocodial armature may differ in the mode of branching, and *vice versa*.

C. That within the limits of a colony there is, in most cases,

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† For explanation of the Plates see p. 77.

relatively little variability of architecture, though there are, of course, quantitative differences in size of spicules, strength of supporting bundle, and the like, which are merely growth characters. I must emphasize the saving clause in most cases, in view of the occurrence of a number of very variable species, such as *D. gigantea*, where there is great variability of anthocodial armature in one and the same colony. In the second part of this paper particular attention is paid to the interesting form referred to; and it does not stand alone.

§ 3. The multiplicity of form detail within a narrow range admits of various interpretations:—

I. (*a*). It may be urged that the observed differences are *individual*, not specific, characters. If the observed differences are purely individual, they may be either extrinsic modifications or of the nature of intrinsic variations. And before considering these alternatives separately, I may note the general answer that in many cases a considerable number of specimens from the same or different localities agree together. Thus Kükenthal speaks of twenty specimens of *D. savignyi*, twelve of *D. gigantea*, ten of *D. rubra*, seven of *D. pumilio*; while I have myself got twelve of *D. ehrenbergi*, ten of *D. gigantea*, ten of *D. clavata*, eight of *D. habereri*, and the same number of *D. hyalina*.

Therefore the general suggestion that observed differences are purely individual does not apply in every case. At the same time, the unsatisfactoriness of basing a new species on a single specimen when the specific characters are of such a tenuous description is plain.

(*b*) It may be said that the observed differences are of the nature of exogenous modifications correlated with environmental peculiarities. Against a too ready acceptance of this easy solution is the occurrence of the same form in widely separated localities. For example, *D. robusta* is reported from Ternate, Borneo, Zanzibar, and Madagascar; *D. florida* from Hong Kong, the Philippines, and Port Jackson (Australia).

It may also be pointed out that certain factors in the immediate environment in different parts of a large colony must show considerable diversity, *cf.* shelter; and yet, as already pointed out, there is rarely diversity in a colony except in colour and the like.

(*c*) It may be, however, that the observed differences are expressions of individual intrinsic variability, not correlated with any peculiarities of environment. There is no way of testing this interpretation until numerous similar specimens from the same locality and of the same age and size are examined by some investigator with abundance of living material at his disposal.

II. It may be that the multiplicity of distinct forms within a narrow range is due to cross-fertilization between allied species.

It is quite conceivable that species which have attained individuality and fixity in the course of isolation and inbreeding may be brought into contiguity by subsequent spreading or removal of barriers. In such a case, analogy points to the likelihood of numerous new patterns arising by permutations and combinations of the previously segregated species. This hypothesis is certainly suggested by the fact that two species may agree in anthocodial armature and yet differ in mode of branching, or may agree in having a foliaceous collar and yet differ in the nature of the supporting bundle. In short, in the distinctions between species there is a distinct suggestion of the shuffling of unit characters.

III. There seems to be a third possible interpretation—namely, a mutation of species apart from any hybridizing influence. It may be that certain widespread and strongly established species such as *D. gigantea*, *D. ehrenbergi*, and *D. brevirama* have been the stocks from which mutations have been thrown off after the fashion of *Œnothera lamarckiana*.

An indirect argument in favour of this interpretation may perhaps be found in the possibility of discriminating similar radiations of evolution within the three great groups : Glomerates, Divaricates, and Umbellates. A more direct argument may be found in the variability of certain species such as *D. gigantea*, to which reference has already been made. As Kükenthal remarks, "Aus diesen Beschreibungen geht hervor, dass *D. gigantea* eine in ihrem Aufbau sehr variable Art ist." ('Revision,' p. 553.)

§ 4. Kükenthal has divided this difficult genus into the three main groups: (I.) Glomeratæ ; (II.) Divaricatæ ; (III.) Umbellatæ, giving precision to similar suggestions by previous workers such as Holm.

I. The Glomeratæ are characterized by :—

(*a*) the comparatively slight branching of the polyparium ;

(*b*) the grouping of numerous bundles of polyps into roundish bunches which make the surface of the polyparium entirely irregular.

There is a marked definiteness about the Glomerate division which suggests "naturalness," and makes it easy to refer a species to the group. Text-fig. 1 is a diagrammatic illustration of what is meant by the Glomerate habit of growth.

II. The Divaricatæ are characterized by :—

(*a*) the profuse branching of the polyparium ;

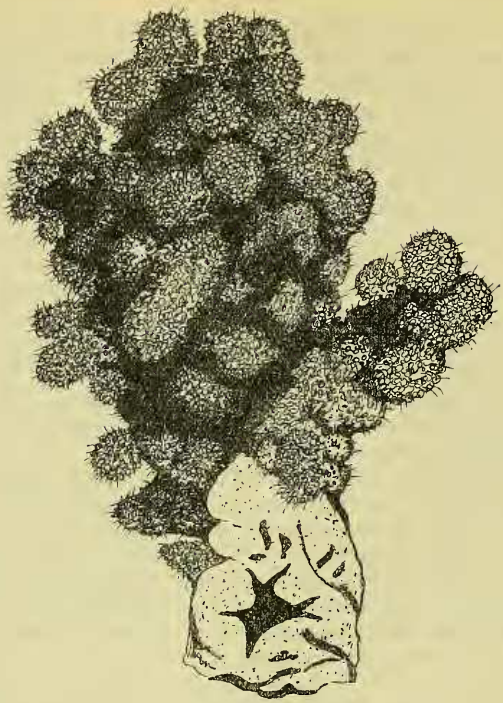
(*b*) the length and slenderness of the twigs ;

(*c*) the divergent separateness of the polyp bundles ;

(*d*) the absence of anything that can be called bunches of the Glomerate type or umbels of the Umbellate type.

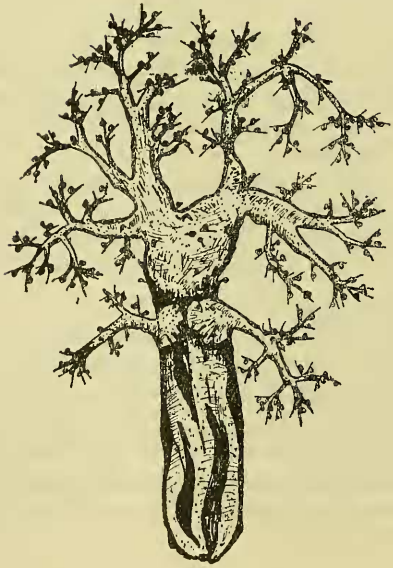
It should be noted that a Divaricate polyparium may have a continuous contour like that of a well-pruned tree (see diagram).

Text-figure 1.



A typical Glomerate.

Text-figure 2.



A typical Divaricate.

III. The Umbellatæ are characterized by:—

(*a*) the umbel-like or sometimes corymb-like aggregates formed by the terminal twigs, the heads of the umbels being bundles of polyps;

(*b*) the disposition of all or most of the polyp heads on the surface of the colony.

Text-figure 3.

A typical Umbellate.

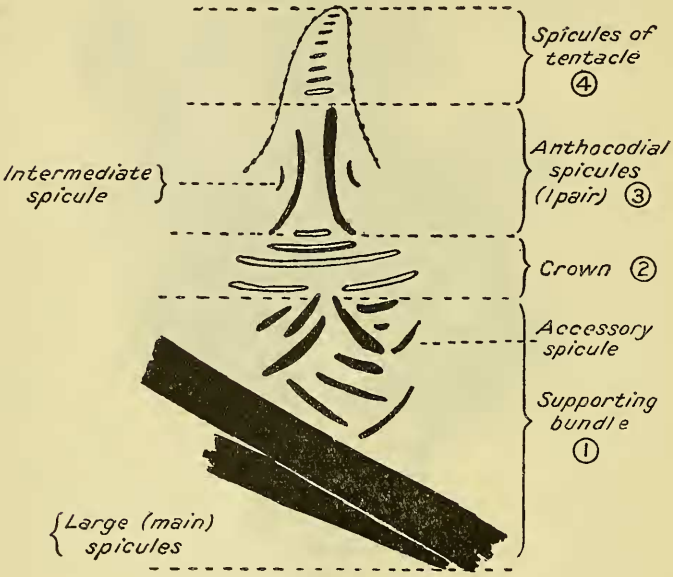
Thus the Umbellatæ differ from the Glomeratæ, and agree with the Divaricatæ in showing much minor branching. They differ from the Divaricatæ in the presence of umbels or corymbs of polyp bundles and in the entirely superficial arrangement of the polyp heads. As this continuous superficial disposition is obviously advantageous—giving all the polyps equal exposure for nutritive and respiratory purposes—we may regard the Umbellatæ as the latest expression of the evolution of the *Dendronephthya* polyparium. Moreover, some Umbellatæ pass through a Divaricate stage.

Of minor importance is the question whether or not the umbels combine into large secondary bunches rising like hillocks on the surface of the polyparium. Nor can I attach more than slight importance to the shape of the polyparium whether flattened or quite symmetrical, whether spherical or disc-like, and so on, for these features probably depend to a large extent on local environmental conditions.

It may be noted that a large and very handsome colony of *D. annectens* was, as a whole, strikingly divaricate at first sight, but a closer inspection soon showed that it was an Umbellate having the terminal twigs massed into distinct umbels. (See Plate III.)

§ 5. Before proceeding to consider the specific characters selected for examination and criticism, it will be well to recognize clearly the typical architecture of a *Dendronephthya* polyp as

Text-figure 4.



Armature of lateral point of Polyp.

regards its external spiculation (text-fig. 4). When every portion is represented, the ascending order above the polyp stalk is as follows:—

(1) The spicules of the supporting bundle (Stutzbündel), several of which are usually very large (often up to 3 or 4 mm. in length) and often projecting beyond the polyp for a distance of 0·5–1·5 mm. It is useful to distinguish in the supporting bundle the main spicules and the accessory spicules, the latter often mingling gradually with those of the polyp stalk.

(2) The "crown," consisting of a few rows, very commonly three, of spicules arranged horizontally round the base of the anthocodial part of the polyp.

(3) The anthocodial armature, in the strict sense, which consists mainly of the spicules entering into the composition of each of the eight points. Between each pair of points tiny spicules are frequently found. These I term intermediates and discount their value because they are so variable.

(4) Very minute spicules on the tentacles, the nature and number of which seem to be quite unimportant.

§ 6. If, as I think probable, the Glomerates, Divaricates, and Umbellates represent three distinct stocks or lines of evolution, the particular problem is to discover whether similar morphological radiations can be discerned in each of these main divisions. A prior question is—What characters can be regarded as having real morphological importance?

1. Negatively, it is quite plain that little emphasis can be laid on the size of the colony, looseness or density of branching, amount of sterile stalk or colour.

2. Positively, the features which seem most indicative of relationship are in order of importance:—

(1) the architecture of the anthocodial armature—*e. g.*, whether crown and points are distinct, the number of spicules in each point, their degree of projection and their differentiation within the point;

(2) the differentiation of the supporting bundle;

(3) whether the polyps are marked by long stalks or are very short-stalked;

(4) characteristic features in the spiculation, such as the occurrence of particular forms in special regions of the colony—*e. g.*, the "sterile stalk," canal-walls.

§ 7. In studying the possible relationships of different species, I make the following provisional assumptions:—

(*a*) That the presence of very numerous small spicules in the anthocodial points is more primitive than a reduced number of large spicules.

(*b*) That the absence of a definite "crown" is more primitive than its differentiation.

(*c*) That a slightly differentiated supporting bundle with a large number of spindles tending to form a sheath rather than a buttress is a more primitive condition than the differentiation of a bundle out of a few large spicules. And here it may be noticed that in a few species—e. g., *D. clavata*, the supporting bundle is so slight that the polyps may at first sight be mistaken for those of a *Eunephthya*, where there is no supporting bundle whatever.

(*d*) That the more primitive forms show:—

(1) less variety of spicule: *i. e.*, are predominantly provided with spindles, the characteristic spicule, and less variety of spicule in the anthocodial point;

(2) less localization of particular forms of spicule in particular areas. Thus there can be no doubt that the presence of special interlocking spicules in the "sterile stalk" is a later differentiation;

(3) the presence of few spicules in the canal-wall.

Thus *D. pütteri* with a multitude of canal-wall spicules is in other respects highly specialized. Conversely, it is interesting that

D. clavata with no canal-wall spicules belongs to what I would call the more primitive types. So careful a worker as Kükenthal attaches great importance to the canal-wall system of spicules, and it is obviously important to inquire what correlation there is between the primitiveness of a species and the number and nature of the canal-wall spicules. The unsatisfactory feature here is that the examination of the canal-wall spiculation has not been made uniformly by the various investigators. Minute spicules which escape attention in a fragment of canal-wall when boiled down may be found by the other method of examining a piece intact. But one is not uniformly successful with the sample examined.

Text-fig. 5.

§ 8. Bearing in mind the first of the above assumptions, it is possible to expand it so as to reduce all the different species to one or other of the following six grades, ranging from the most primitive (I.) to the most specialized (VI.):—

VI. Only one pair of spicules, or even but a single spicule replacing all the others in each point above the crown;

V. reduction of the point that one pair (or, it may be, one of the uppermost pair) predominates over the others, which are not above three pairs in total number above the crown;

IV. one pair or one spicule predominating over 3–4 others, no crown;

III. about 4–6 pairs, the uppermost slightly specialized, no crown;

II. about 6–8 pairs, strong and uniform, no crown;

I. about 8–12 pairs in each poin t numerous and small, rising from indefiniteness to definiteness, no crown.

§ 9. The suggestion has been made by critics of *Dendronephthya* species that the differences between the Glomerate, Divaricate, and Umbellate groups are not of taxonomic value, but

depend on conditions of growth. On this view, the occurrence of a species with the same anthocodial armature in each of the three groups would not mean that a similar specialization had occurred three times on different lines of evolution; it would mean that one and the same species occurred in three different vegetative forms—Glomerate, Divaricate, and Umbellate, which depended on growth conditions.

For various reasons this view is improbable:—(1) In many cases the Glomerate, Divaricate, or Umbellate mode of growth is clearly expressed in young forms 1–3 cm. high. (2) When exactly the same anthocodial armature occurs in two or all of the three groups, the two or three species in question differ in other details, such as the length of the polyp stalk, the nature of the supporting bundle, and the spiculation. This does not look like the occurrence of the same species in three vegetative guises. There are Umbellate colonies, however, which seem to pass through a Divaricate stage when they are young and small, but these are in my experience fewer than forms which are Umbellate from near the start.

Text-figure 6.

In support of the view that a colony usually shows very early whether it is going to be Glomerate, Divaricate, or Umbellate, I have given a series of diagrammatic representations of a dozen small colonies drawn to actual size. It goes without saying that the definite architecture cannot be expressed until there are quite a number of polyps in the colony. But the limit is uncertain. The central figure of the group depicts the primitive, quite undifferentiated colony from which soon the distinctive form embodies itself. Above it to the left are Glomerates, to the right Umbellates, while below is a row of Divaricates.

§ 10. Starting with the Glomeratæ, I suggest that the following should be regarded as illustrations of primitive types:—

1. In the *savignyi* group:—

D. argentea with irregular arrangement—most primitive of all,

with ventrally and laterally nothing more than minute cylindrical corpuscles. *D. fusca* with indefinite double rows of about 6 pairs—on a slightly higher level, but also showing primitiveness in numerous quite small elements. *D. savignyi* with indefinite steep double rows reduced to 6—somewhat higher, but also showing, like the preceding, very numerous small cylindrical bodies.

2. In the *hemprichi* group:—

D. clavata, where occur 10–12 pairs in each double row and a very weak supporting bundle. It may be noted that in this group we have a gradual reduction in the number of spicules composing each point 5–7, 5–6, 4, 3, 2 and 1, reaching a climax in forms like *D. punicea*, where are found a couple of slightly hockey-club like spicules occupying the whole area which in *D. clavata*, for instance, shows 10–12 pairs.

3. In the *studeri* group:—

Here we have, on the whole, a more differentiated group with forms like *D. mayi* with 6–8 pairs in each point to be ranked as relatively primitive compared with the highly-specialized *D. köllikeri*.

§ 11. So with the Divaricates, on my view the series begins with forms like *D. japonica* with 8 pairs in each point, none protruding—a very primitive arrangement—and ends with *D. suensoni*, which has but one pair. As intermediate between grade II., which I define as having numerous pairs regularly arranged in each point (grade I. possessing very numerous irregular pairs), and grade III., with 5–6 equal pairs, we have cases like *D. armata*, where the lateral points go up to 9 pairs. There must also be noticed *D. cærulea* inclining to be primitive in minuteness but not in number of spicules, while *D. klunzingeri* may be considered as rising out of grade II. because one of the uppermost pairs is very prominent.

It is interesting to see that in so many of Kükenthal's minor groups his arrangement of the species ends in one pair, so that the anthocodial armature, which I hold to be the evolutionary key, is, as used by Kükenthal, very probably just diagnostic.

Again, in the *rigida* group, *D. microspiculata* is undoubtedly primitive with 6–8 pairs, though the uppermost again is slightly larger and projecting.

§ 12. In the third great division—the Umbellates—grade I. is represented by *D. australis* with its very numerous, small polyp spicules, grade II. perhaps by *D. umbellulifera* with 6–8 pairs and the practical absence of a supporting bundle.

In the *dendrophyta* group, *D. villosa* belongs to grade I. with many spicules in each double row, while grade II. in the *florida* group may be illustrated by *D. brevirama* (with 6–8) and *D. florida* (with 5–7).

D. pectinata must be regarded as the climax in the line of evolution.

Again in the *rubra* group, grade I. is well represented by *D. repens*, while in the *spinulosa* group, grade II. is probably represented by *D. spinulosa* itself with 6–8 pairs very small and not projecting, even better by this than by *D. flabellifera* where we have 8–9, but in which I recognize what I regard as the beginning of differentiation: viz., a specialization of the highest pair.

In tabular form my conclusions may be represented as follows:—

	I.	II.	III.
Grade.	Glomerates.	Divaricates.	Umbellates.
VI.	*D. punicea* (Stud.) *. D. carnea (Wr. & Stud.). D. dœderleini (Kük.).	D. pütteri (Kük.). *D. suensoni* (Holm). *D. orientalis* (Hend.). *D. flammea* (sp. n.). *D. cervicornis* (Wr. & Stud.). D. laxa (Wr. & Stud.).	D. lutea (Kük.). *D. longicaulis* (Kük.). *D. simplex* (sp. n.).
V.	——	D. eburnea (Kük.).	*D. coronata* (Wr. & Stud.).
IV.	D. spinifera (Holm). D. köllikeri (Kük.).	*D. mollis* (Holm). D. cirsium (Kük.). D. involuta (Kük.). *D. mirabilis* (Hend.).	*D. disciformis* (Kük.). D. rubra (May). *D. pumilio* (Studer). D. nigrescens (Kük.). *D. collaris* (Wr. & Stud.). D. sinensis (Püt.).
III.	D. studeri (Ridley). *D. gigantea* (Verr.).	——	D. dendrophyta (Stud.). *D. hyalina* (Kük.). D. mexicana (Kük.). D. florida (Esper).
II.	D. mayi (Kük.). D. hemprichi (Klunz.).	*D. klunzingeri* (Stud.). *D. ehrenbergi* (Kük.). D. japonica (Kük.). *D. microspiculata* (Püt.). D. erinacea (Kük.).	*D. brevirama* (Burch.). D. umbellulifera (Kük.). D. spinulosa (Gray). *D. habereri* (Kük.). *D. annectens* (sp. n.).
I.	D. argentea (Kük.). *D. clavata* (Kük.).	——	D. villosa (Kük.). D. australis (Kük.). D. repens (Kük.).

* The species printed in italics are those worked out from the *Dendronephthya* collection of the 'Siboga' Expedition.

As a convenient means of expressing the composition of the anthocodial point, I have drawn up an anthocodial formula on the following lines:—The spicules of the point are denoted by "P" if big and strong, and by "p" if small and weak; those of the crown by "Cr", and the supporting bundle by the letters "S.B." preceded by a qualifying adjective, such as weak, medium, very strong, etc. In this way the anthocodial grade and formula of *D. annectens*, for example, can be set forth briefly as:

II. = 8 p + 0 Cr + very weak S.B.

Part II.—Description of Species taken by the 'Siboga' Expedition.

Table of Species.

Genus Dendronephthya (Kük.).	Number examined.	Locality.	Previously reported from
		I. GLOMERATÆ.	
1. D. clavata (Kük.)	10	Station 302.	S.W. of Japan.
2. D. gigantea (Verr.)	10	Stations 165, 213, 240, 261, 303.	Japan, Hong Kong
3. D. punicea (Stud.)	1	Station not marked.	Japan.
		II. DIVARICATÆ.	
4. D. ehrenbergi (Kük.)	12	Stations 164, 258.	Red Sea.
5. D. suensoni (Holm)	2	Station 164.	Japan.
6. D. mollis (Holm)	4	Stations Amboina Reef, 310 B, 366.	Japan.
7. D. cervicornis (Wr. & Stud.)	2	„ 305, 310.	Lifu, Funafuti, Kei.
8. D. mirabilis (Hend.)	2	„ 99, 282.	Andamans.
9. D. flammea (sp. n.)	2	Station 91, Macaras Reef.	——
10. D. klunzingeri (Stud.)	2	„ 164 E.	Red Sea.
11. D. microspiculata (Pütter)	2	„ 315.	Philippines, Hong Kong, Amboina.
12. D. orientalis (Hend.)	4	„ 125, East of Polloe Weh.	Andamans.
		III. UMBELLATÆ.	
13. D. collaris (Wr. & Stud.)	2	Station 99.	Kei.
14. D. longicaulis (Kük.)	1	„ 310.	Japan.
15. D. disciformis (Kük.)	6	Stations 99, 164.	China Sea.
16. D. habereri (Kük.)	8	„ 258, 282.	Japan.
17. D. pumilio (Studer)	4	„ 99, 258, 315.	Japan.
18. D. coronata (Wr. & Stud.)	3	Station not marked.	Torres Straits.
19. D. brevirama (Burch.)	6	Stations 164, 258.	Torres Straits, China Sea.
20. D. annectens (sp. n.)	1	Station not marked.	——
21. D. simplex (sp. n.)	1	„ not marked.	——
22. D. hyalina (Kük.)	8	Stations 257, 318, 321.	Pescadores.
Total	93		

I. GLOMERATÆ.

1. **Dendronephthya clavata** (Kükenthal). (Plate 1.)

Described by Kükenthal, 'Revision der Alcyonarien,' pp. 545–6 (1905).

Diagnosis :—Glomerate; with great bare gap between the collar and the polyp-bearing area; polyps in dense groups at the ends of the terminal branches; polyp stalks very long; supporting bundle weak; point spicules 7–8 pairs, short and uniform; no distinct crown; grade I.; tentacles with tiny, flat, jagged spicules; the foliaceous collar with large curved spindles and

small, quaint, flattened forms; colour: general cortex and sterile stalk yellow, collar vivid red, anthocodial armature whitish, twigs and polyp stalks with red spicules.

* Anthocodial Grade and Formula:—

I. = ∝ P + 0 Cr + *weak* S.B.

Descriptive Notes:—

1. *Colony as a whole.* Ten specimens of a peculiar form, the smallest 15 mm. in height, the largest 17 cm. They are remarkable in showing, especially in the larger forms, a great bare gap between the collar and the loosely glomerate polyp-bearing area. In the largest specimen this interval extends for about 6 cm. Here and elsewhere it is extremely limp, and it looks as if the polyp-bearing area had rested on the mud. In the upper part of the colony there are numerous galls due to and containing small Balanidæ, and the polyps are very muddy. It should be noted as a feature that the upper part of the polyparium is distinctly top-heavy; in the largest specimen it has a breadth of 10 cm., whereas the stalk bearing it is only 1 cm. across. The colony broadens again at the very foliaceous collar and measures 6 cm. from side to side. Below that the sterile stalk, which is markedly flattened, measures 3·5 cm. in breadth. There are numerous stolons.

2. *Branching.* The three largest specimens show two lateral short branches arising immediately above the collar, but not affecting the bareness of the gap alluded to.

Text-fig. 7.

D. clavata Kük.

3. *Colouring.* The twigs and polyp stalks bear red spicules; the anthocodial armature is whitish or transparent; the general cortex is yellowish; the collar is of a very conspicuous red; the sterile stalk has the same colour as the general cortex.

4. *Polyp stalks and their spicules.* The length of the polyp stalks is very great—often reaching 3 mm. in the collar and about 1·5 mm. in the upper polyparium. The spicules are red and very thorny.

5. *Polyps.* Found in dense groups at the tips of the end branches.

6. *Polyp spicules.* The anthocodial architecture is primitive, having 7 or 8 pairs of very uniform short rod-like spindles in each point and no distinct crown. The supporting bundle is

* In the anthocodial formulæ the point spicules are denoted by "P" if big and strong, and by "p" if small and weak; the crown spicules by "Cr," and the supporting bundle by "S.B." preceded by a qualifying adjective (*cf.* page 43).

very weakly developed and shows only occasionally a projecting needle.

7. *Other spicules.* Those of the sterile stalk are almost entirely small, star-shaped forms. In the foliaceous collar we find (1) large, curved, almost smooth spindles up to 5 mm. in length; (2) quaint, flattened forms, like biscuit-fingers in shape, not exceeding 1 mm.; (3) the small red, rough spicules of the anthocodia; and (4) the tiny, flat, jagged ones of the tentacles.

Salient Features:—The peculiar mode of growth (which seems to be unique), the limpness of the whole colony, the length of the polyp stalks.

I refer my specimens to *D. clavata*, although Kükenthal's description does not mention any growth peculiarity such as has been noted here. The important points of agreement are the following:—

(1) a glomerate mode of branching (Glomeratæ), with the polyp-bearing twigs predominating over the stem and main branches in building up the polyparium (*hemprichi* group);
(2) a primitive anthocodial armature with 7–8 (*D. clavata* 10–12) pairs of very uniform, short, rod-like spindles in each point; no distinct crown;
(3) a very weakly developed supporting bundle which only occasionally shows a projecting needle;
(4) a long polyp stalk of from 1–2 mm. (about 1 mm. in *D. clavata*);
(5) a well-developed foliaceous collar;
(6) an almost exclusive occurrence of small, plump stars and double stars in the cortex of the sterile stalk;
(7) a practically complete absence of spicules from the canal-walls. With agreements so numerous it seems entirely justifiable to disregard the extraordinary growth peculiarities.

Locality:—Station 302.

2. **Dendronephthya gigantea** (Verr.). (Plate II.)

Described by Verrill, Bull. Mus. Comp. Zool. Cambridge, p. 40 (1864).

Diagnosis:—Glomerate; with numerous rounded, polyp-bearing masses, the lowest branches slightly foliaceous; polyps densely arranged in characteristic hemispherical masses; polyp stalks short, under 1 mm.; supporting bundle very strong; point spicules very variable, 1–6 pairs; no crown; grade IV.; spicules of the upper cortex are large (4 mm.), covered with blunt warts and lie transversely, lower cortex and canal-walls have stouter and shorter spindles, triradiates and multiradiates; colour: cortex white, polyps deep orange.

Anthocodial Grade and Formula :—

III. = (1—6) P + 0 Cr + very strong S.B.

Descriptive Notes :—

1. *Colony as a whole.* Two handsome orange-coloured colonies, the largest 28 cm. wide and 20 cm. high, eight others smaller in size.

2. *Branching.* Markedly glomerate. The numerous rounded, polyp-bearing, boss-like masses predominate over the stem and main branches. Therefore the colonies must be included in Kükenthal's *hemprichi* group. The lowest branches of the colony show slight foliation.

3. *Colouring.* Generally deep orange-coloured polyps and white cortex. The colony from station 240, however, showed quite a different colour-scheme, viz. bright red spindles in the supporting bundle and anthocodiæ, but the general cortex greyish with opaque, white, almost porcellanous spindles.

4. *Polyp stalks and their spicules.* Short, under 1 mm.

5. *Polyps.* Densely arranged in very characteristic plump hemispherical masses of 7 or so.

6. *Polyp spicules.* The anthocodial architecture without entering into details, may be noted as having the 8 points often elongated with the tips meeting above the polyp. Another feature is the practical absence of any true crown. Kükenthal notes in his definition of *D. gigantea* that each of the 8 points has 5–6 pairs of spicules, the uppermost much larger than the others and markedly projecting. It is easy enough to find on the specimens anthocodiæ which exactly correspond with this description.

Text-fig. 8.

D. gigantea Verr.

Text-fig. 9.

D. gigantea Verr.

Yet on the same colony may be found points with 5, 4, 3, or 2 pairs, and finally even a single pair, abutting against a few transitional small spindles leading on to the supporting bundle.

Great care was taken to avoid damaged or disturbed anthocodiæ, and the annexed diagrams show a series of frequently recurring types of architecture.

A general feature may be noted that in the great majority of cases the two uppermost predominate, and that when the number

is reduced to 2 pairs or to 1 pair, these occupy the same space as 3–6 rows. The larger numbers 5–6 were certainly less frequent than the rest.

There is not in this case any confusion between what might be counted to points and what to crown, for in no case did I see what in other species is called a crown. It is also striking that after an examination of scores of anthocodiæ hardly any case of intermediate spicules between the points was found.

The supporting bundle is enormously developed. Its largest spicules may attain to a length of 6 mm. and project for 1·5 mm. These large spindles are densely covered with minute, blunt, thorns, except for 0·6 mm. at the projecting tip, which is smooth, as is also the case in *D. gigantea*. Very marked in the large supporting-bundle spicules of the colony (Station 240) is the disappearance of the red colour from the proximal third of most of the largest. The same tendency is to be recognized in the yellow colonies.

7. *Other spicules.* The spindles of the upper cortex are often up to 4 mm. in length. They are covered with large, blunt, truncate and sometimes compound warts, and they lie transversely. Many show an abrupt narrowing at one end. In the lower cortex and canal-walls there are numerous stouter and shorter spindles exceeding 1 mm. in length and bearing crowded, rough tubercles often compound. Large triradiates and multiradiates also occur, besides bracket-like and quite irregular forms approaching the stellate type. A few curiously starfish-like forms occur, and triradiates with one arm exuberantly branched. Many much smaller counterparts of the large types occur. There are also occasional long, narrow spindles.

Within the *hemprichi* group the specimens agree best with *D. gigantea*, though this may not be obvious at first sight. Many of the anthocodiæ show but one pair of spicules in each point, which suggests approximation to *D. carnea*, *D. dœderleini*, and *D. punicea*. From the first they are at once separated by the massive spicules, which are visible from a distance and lie in very regular transverse rows. This conflicts too seriously with the original description by Wright and Studer (p. 196), where it is said: "The stem and branches . . . . . are leathery and thickly packed with fine spicules. The latter are not recognisable by the unassisted eye and lie scattered confusedly in several layers." Both from *D. dœderleini* and from *D. punicea* they are sufficiently separated by the enormous strength of the supporting bundle.

Deduction:—The specimens agree more closely with *D. gigantea* than with any other Glomerate known to me, and not least in showing quite an unusual degree of variability. Among the important features of agreement the following may be noted:—

(1) the very characteristic plump hemispherical masses closely beset with polyps;
(2) the supporting bundle of great strength and showing many

spindles of over 4 mm. (the maximum size mentioned for *D. gigantea*) and projecting for 1·5 mm.;

(3) the large spindles of the supporting bundle densely covered with minute, blunt thorns, except for the last half millimetre at the projecting tip, which is smooth as in *D. gigantea*;

(4) the spindles of the upper cortex frequently reach 4 mm. in length, are covered with large, blunt warts, and lie transversely;

(5) the spicules of the lower cortex and of the canal-walls;

(6) the eight anthocodial points are often elongated and have the tips meeting over the polyp;

(7) the lowest branches of the colony show slight foliation;

(8) the colour-scheme of deep orange polyps and white cortex was found in some of the described species of *D. gigantea*.

Localities:—

Station 165 (3 specimens). Station 240 (3 specimens).
„ 213 (1 specimen). „ 261 (2 specimens).
„ 303 (3 specimens).

3. **Dendronephthya punicea** (Studer).

Described by Studer, Ann. Mag. Nat. Hist. (6) vol. i. p. 70 (1888).

Diagnosis:—Glomerate; bundles of polyps in rounded clusters; main stem and main branches little developed; polyps closely crowded together, polyp stalks medium; supporting bundle strong; point spicules two only, strong and converging; crown of about three rows of spicules irregularly disposed; grade VII.; spicules: upper cortex has big, strong, thick spindles (2 mm.), lower cortex smaller and more thorny forms, including roundish and stellate types; colour: branches and all spicules scarlet; polyps pale yellow.

Anthocodial Grade and Formula:—

VI. = 2 P + 3 Cr + *strong* S.B.

Descriptive Notes:—

1. *Colony as a whole.* A handsome Glomerate colony, with the bundles of polyps forming rounded clusters, often well separated from one another.

2. *Branching.* There is relatively little development of the main stem and main branches as compared with the stalks of the bundles of polyps composing the clusters. It is therefore one of the *hemprichi* group.

3. *Colouring.* Branches and all spicules scarlet while the polyps themselves are pale yellow.

4. *Polyp stalks and their spicules.* The polyp stalks measure almost 1 mm. in length.

5. *Polyps* closely crowded together.

6. *Polyp spicules.* The anthocodial armature has each point

consisting of two strong, very thorny, converging spicules bent at the base in hockey-club-like fashion, one slightly larger than the other. Between adjacent points lie a pair of much smaller, straight spindles longitudinally disposed, but in some cases there seem to be two pairs (thus connecting with *D. dœderleini*). Below the points there is a crown of horizontal spindles in two or three rows, rather irregularly disposed.

Text-fig. 10.

D. punicea Stud.

The supporting bundle is strongly developed, especially as regards the three uppermost spindles, the lower median one of which projects for almost 1 mm.

Deduction :—Among the members of the *hemprichi* group there are several with only one pair of spicules in each of the anthocodial points, and beside these this specimen must be ranked.

It agrees very closely with *D. punicea* in the following features :—

(1) each anthocodial point composed of two spicules, one slightly larger than the other ;
(2) between adjacent points usually a single pair of small intermediate spicules ;
(3) below the points the crown of horizontal spindles is present with two or three rows ;
(4) the strong supporting bundle.

Locality :—Station not marked.

II. DIVARICATÆ.

4. **Dendronephthya ehrenbergi** (Kük.).

Described by Kükenthal, ' Korallentiere des Rothen Meeres,' p. 56 (1904).

Diagnosis :—Divaricate ; contours irregular ; polyps in little groups of 5–8 ; polyp stalks short ; supporting bundle medium ; point spicules 6 pairs ; crown absent ; grade III. ; spicules : canal-walls show few bent rough spindles, the stalk cortex has very distinctive long curved red spindles and irregular clubs, discs, and spheres ; colour : rich red in the cœnenchyma, anthocodial spicules grey-yellow, polyp spicules of the points white.

Anthocodial Grade and Formula :—

II. = 6 p + 0 Cr + medium S.B.

Descriptive Notes :—

1. *Colony as a whole.* Ten specimens in all, including two fine specimens agreeing closely with Kükenthal's definition of this species, the largest 40 cm. in length.

2. *Branching.* Markedly divaricate but not markedly flattened. The contour of the colony is irregular. These features point to the *suensoni* section, and in that section the only species to which the specimens could be referred is *D. ehrenbergi.* The mode of branching is the same, and the resemblance of these specimens to Kükenthal's coloured figures is striking except that they have much less of a sterile stalk.

3. *Colouring.* Rich red in the cœnenchyma and with greyish-yellow anthocodial spicules.

4. *Polyp stalks* short.

5. *Polyps* arranged in little divaricate groups of about 5–8.

6. *Polyp spicules.* There are in most 6 pairs of white spicules arranged *en chevron* in each of the anthocodial lines: in Kükenthal's forms there were 4–5. There is no very distinct crown. The supporting bundle consists of thick, rough red spindles (up to 1·5 mm.), projecting freely for about 0·5 mm.

7. *Other spicules.* The canal-walls show a few bent, rough spindles. The spicules of the stalk cortex are mostly very distinctive, long (up to 3·5 mm.), curved, red spindles, also ovals and irregular clubs covered with massive tubercles mainly with very characteristic rough blunt heads. There are also very rough discs, approaching spheres, covered with the same massive tubercles. A few triradiate forms occur in the lower cortex. Not very numerous, there are also minute, colourless, irregular capstans.

Text-fig. 11.

D. ehrenbergi Kük.

Deduction:—The specimens agree with *D. ehrenbergi* in having:—

(1) 6 pairs of spicules, in most cases, in the anthocodiæ;
(2) supporting bundle of rough spindles slightly projecting;
(3) polyps in little divaricate groups of about 5–8;
(4) spiculation of the canal walls;
(5) mode of branching.

Localities:—Stations 164, 258.

5. **Dendronephthya suensoni** (Holm).

Described by Holm, Zool. Jahrb. viii. Syst. pp. 35–37 (1895).

Diagnosis:—Divaricate; outline irregular; not obviously flattened; polyps in little groups (4–10), distinctly scattered; polyp stalks medium; supporting bundle medium; point spicules one pair only, of which one member is a long projecting curved spindle associated with a much smaller one at its base; crown of some 6 rows of horizontally disposed spindles; grade VI.;

spicules: canal-walls show numerous forms with greatly developed thorns; colour: cortex and polyps have deep red spicules, polyps grey-yellow.

Anthocodial Grade and Formula:—

VI. = I + 1 P + 4–6 Cr + medium S.B.

Descriptive Notes:—

1. *Colony as a whole.* Two handsome colonies agreeing very well with Holm's figures.

2. *Branching.* Markedly divaricate, of irregular outline, not obviously flattened, and should be referred to Kükenthal's *suensoni* group of the Divaricatæ.

3. *Colouring.* Deep rose-red spicules on cortex and polyps; polyps themselves apart from the spicules are yellowish grey.

Text-fig. 12.

D. suensoni Holm

4. *Polyp stalks* about 1·3 mm. long.

5. *Polyps* in little groups (4–10) distinctly scattered.

6. *Polyp spicules.* Anthocodiæ show 8 points, each consisting of a long, projecting curved spindle with a much smaller one at its base, the two being obviously members of a pair. These points rise from a crown of about 6 rows of horizontally disposed curved spindles. The supporting bundle consists of only three strong spindles up to 3 mm. long, one of which projects for only a short distance.

7. *Other spicules.* The canal-wall contains numerous forms with conspicuously developed thorns.

Locality:—Station 164.

6. Dendronephthya mollis (Holm).

Described by Holm, Zool. Jahrb. viii. Syst. pp. 51–53 (1895).

Diagnosis:—Divaricate; contour regular; not flattened; polyps in groups of about 10; polyp stalks medium; supporting bundle very strong; point spicules 4 pairs with uppermost pair (or one of that pair only) strong and projecting; no crown; grade IV; spicules: stalk has rough spindles, triradiates and quadriradiates; colour: general surface white, anthocodial armature and supporting bundles red-brown.

Anthocodial Grade and Formula:—

IV. = 1–2 P + 3 p + 0 Cr + very strong S.B.

Descriptive Notes:—

1. *Colony as a whole.* Four colonies of white general surface, two of which are obviously young and are fragmentary.

2. *Branching.* Divaricate, regular outline, not flattened.

Should be referred to Kükenthal's Divaricatæ and section *divaricata*, within which they approach *D. mollis*.

3. *Colouring*. General surface white, anthocodial armature and supporting bundles reddish brown in the largest specimen. In the two younger colonies the anthocodial and supporting-bundle spicules are amber-yellow. The fourth colony is ivory-white.

4. *Polyp stalks* about 1 mm. long.

5. *Polyps* arranged in groups of about ten in number.

6. *Polyp spicules*. One of the uppermost pair of spicules in at least some of the 8 points is strong, out of proportion to the others and projects very markedly beyond the polyp. The other spindles of the points are small and converging, and there may be 4 pairs of them. In many cases the large projecting spindle has fallen off, and its attachment seems to be very loose.

Text-fig. 13.

D. mollis Holm

The supporting bundle is very strongly developed and 3 or so of its component spicules project beyond the polyp for over 1 mm. The spindles are densely and regularly covered with very small blunt tubercles, while here and there almost smooth forms occur.

7. *Other spicules*. Those of the short stalk include, besides spindles much rougher than those of the anthocodiæ and more curved, various triradiate and smaller irregular quadriradiate forms.

Locality :—Amboina Reef.

The two young divaricate colonies with amber-yellow anthocodial and supporting-bundle spicules have distinct flattening, and show what we regard as essential characteristics of *D. mollis*, viz :—

(1) a very marked projection of one of the uppermost spicules of each point in the anthocodial armature ;
(2) the presence of 3 or 4 other pairs of smaller spicules converging *en chevron* ;
(3) the practical absence of any crown ;
(4) the very strong supporting bundle with 3 specially strong spicules, one of which projects beyond the others for about one millimetre :
(5) the dense regular covering of the anthocodial, supporting-bundle, and cœnenchyma spicules with short blunt tubercles ;
(6) the prevalence on the short stalk of much rougher spindles (straight, curved, and much curved), with much longer and more distant tubercles, and along with these numerous, irregularly shaped, roughly tuberculate forms.

A few spindles occur with asymmetrical, bifid ends. The polyp stalks are longer than in the other forms.

Locality :—Station 310 B.

The fragmentary, ivory-white colony, without a stalk, divaricate in type, in its branches inclined to be flattened, closely approaches *D. mollis* in showing :—

(1) a very marked projection of one of the uppermost spicules of each point;
(2) the others (usually 3 pairs in number) much smaller;
(3) a very strong supporting bundle with 3 specially strong spicules, one of which projects for at least 1 mm.;
(4) the dense regular covering of the spicules with short, blunt tubercles.

Most of the spicules are curved spindles, many boomerang-like; bifid and trifid forms occasionally occur; here and there one is almost quite smooth as also occurs in *D. mollis*.

Locality :—Station 366.

Deduction :—It appears to me that the most striking feature of this species is the exaggeration of one of the terminal spicules of certain anthocodial rows, but I emphasise the point that many of the heads show not a trace of this.

7. **Dendronephthya cervicornis** (Wright & Studer).

Described by Wright & Studer, Rep. Sc. Res. 'Challenger,' vol. xxxi. pp. 220–221 (1889).

Diagnosis :—Divaricate; rigid; outline irregular; distinctly flattened; polyps loosely spaced; polyp stalks long; supporting bundle very strong; point spicules one pair only, one member of which is stronger than the other and projects somewhat; crown of about 5 rows closely packed together; grade VI.; spicules; stalk surface has numerous rough multiradiate interlocking discs; colour: bright orange as a whole.

Anthocodial Grade and Formula :—

VI. = 2 P + 4–5 Cr + strong S.B.

Descriptive Notes :—

1. *Colony as a whole.* An approximately rigid, bright orange, young colony.
2. *Branching.* Markedly divaricate; outline irregular and flattened; should therefore be referred to Kükenthal's *cervicornis* group in which, however, the only species that it approaches closely is *D. cervicornis* itself.
3. *Colouring.* Bright orange as a whole.
4. *Polyp stalks* long.
5. *Polyps* divergent and loosely spaced.
6. *Polyp spicules.* The composition of the anthocodial armature

shows 4–5 horizontal spindles closely packed in a crown and of a pair of converging spindles in each of the 8 points, one member of the pair often larger than the other and projecting a little beyond the polyp. The supporting bundle is very strong, and in it one spindle may attain a length of 3 mm.

Text-fig. 14.

D. cervicornis Wr. & Stud.

7. *Other spicules.* The surface of the stalk is densely covered with roughly tuberculate multiradiate discs, often with a central knob, which fit into each other.

Deduction :—This specimen does not agree with previous descriptions in colouring or in showing foliaceous basal branches, yet I think it should be ranked within the heading of *D. cervicornis.*

Localities :—Stations 305, 310.

8. **Dendronephthya mirabilis** (Henderson).

Described by Henderson in ' Alcyonarians of the Indian Ocean,' Part II. pp. 49–51 (1909).

Diagnosis :— Divaricate ; loose ; contour irregular ; distinctly flattened ; polyps in small bundles of about 6 ; polyp stalks medium ; supporting bundle medium ; point spicules 5 pairs, with the uppermost pair slightly projecting ; crown absent ; grade IV. ; spicules : many of the stalk spicules characteristic in appearance because of the length and strength of the protuberances ; colour : colony as a whole white, polyp stalks, point spicules, and supporting bundle amber-yellow.

Anthocodial Grade and Formula :—

IV. = 5 p + 0 Cr + medium S.B.

Descriptive Notes :—

1. *Colony as a whole.* A white, divaricate colony.

2. *Branching.* Loose, divaricate, with irregular contour and very distinct flattening. It should therefore be referred to Kükenthal's group Divaricatæ, subgroup *cervicornis.* Yet it agrees in several respects with Henderson's *D. mirabilis*, which he places in the *rigida* group.

3. *Colouring.* Polyp stalks, spicules of the anthocodial armature and of the supporting bundle amber-yellow.

4. *Polyp stalks* not more than 1 mm. long.

5. *Polyps* occur in small bundles of about 6 in number.

6. *Polyp spicules.* The anthocodial armature consists of 8 double rows of about 5 pairs, converging steeply, and with the uppermost pair slightly projecting. This does not agree well

with Henderson's description and figure. The supporting bundle is moderately developed and has about 3 projecting spindles, one of them slightly longer than the others. The projecting portion is about a third of a millimetre in length.

7. *Other spicules.* What is most characteristic of this specimen and Henderson's is the appearance of many of the stalk spicules. They are spindles straight and curved, spindles approaching clubs and very rough at the broad end, irregular bodies and many quadriradiates, all marked by the length and strength of their spines and protuberances, which are sometimes compound and often tuberculate. Some of the curved spindles have these prominent processes especially strong about the middle, while others are very markedly unilateral, with a few tubercles on one side and a great array of long, often divaricate processes on the other. These unilateral processes are strongest at one end of the spicule and wane towards the other. Among the extraordinary forms, which present an appearance unusual in the genus, there are commonplace straight spindles with small regular spines and tubercles.

Text-fig. 15.

D. mirabilis Hend.

Localities :—Stations 99 and 282.

9. **Dendronephthya flammea** (sp. n.).

Diagnosis :—Divaricate ; outline quite irregular ; markedly flattened ; lower branches somewhat foliaceous ; polyps in small branches of 3–6, but many isolated polyps occur ; polyp stalks very short ; supporting bundle strong ; point spicules one strong pair ; crown of 4–5 rows of straight rough spindles ; grade VI. ; spicules : sterile stalk has large rough yellowish spindles along with small red interlocking forms ; no spicules found in the canal-walls ; colour : brilliant red as a whole, spicules of the branches and twigs deep red.

Anthocodial Grade and Formula :—

VI. = 2 P + 3–4 Cr + strong S.B.

Descriptive Notes :—

1. *Colony as a whole.* Two colonies, the larger measuring 17 cm. in height, including the 3·5 cm. sterile stalk, by 10 cm. in breadth.

2. *Branching.* Divaricate, quite irregular in contour, markedly flattened. The lower branches are somewhat foliaceous, but do not form a collar. It ought to be referred to the *cervicornis* group of Kükenthal's Divaricatæ and to the subdivision with short polyp stalks ; but it does not agree with any of the three species

there included, nor with any other Divaricatæ approaching this group. Each of the half-dozen main branches ramifies irregularly in a flabellate fashion, but there tends to be a predominance of secondary branches to the one surface, though the surface is richly beset with small, almost sessile bundles of polyps, which also occur all over the cortex. These small bundles may, of course, be young stages of twigs.

3. *Colouring.* Predominantly of a brilliant red. The cortex is vividly coloured except at the beginning of the polyparium, where it is almost white. On the branches and twigs all the spicules are deep red.

4. *Polyp stalks* very short.

5. *Polyps.* A somewhat marked feature is the small number (3–6) of polyps in each bundle and the frequency of isolated single polyps.

6. *Polyp spicules.* The anthocodial armature consists of 8 strong points, each composed of 2 rough hockey-club spicules rising from a strongly-developed crown of 4–5 practically horizontal rough spindles. A deceptive appearance arises in many cases where the non-retracted state of the polyp brings the crown spicules into a chevron arrangement in a line with the upper pair of what I take to be the point proper. The two hockey clubs, which form a narrow isosceles triangle, are seen in other cases in the normal relation of points to crown, and it may be noted that they are distinctly larger than those beneath them. Between every two points there are usually two intermediates. On the whole in anthocodial structure the arrangement is nearest to that of *D. cirsium.* The anthocodial spicules are almost white, but show a faint yellowish tinge. They are characteristically rough, with relatively large, very blunt tubercles, not densely crowded.

Text-fig. 16.

D. flammea, sp. n.

The supporting bundle is well developed and inclined to be of the sheath type, showing 3 spindles much larger than the rest—that is to say, a median and two laterals abutted by numerous smaller ones, which show a tendency to be in parallel lines sloping towards the support. The median spindle usually projects for about 0·5 mm., and the two laterals project sometimes a very little. The supporting sheath spicules are spindles often curved and densely covered with short, rounded tubercles.

7. *Other spicules.* On the sterile stalk are large, broad, rough, yellowish spindles connected by small interlocking irregular reddish forms which produce an arenaceous appearance. The cortex here bears a variety of spicules, all thickly covered with rather massive, blunt, rough tubercles, sometimes compound and

well suited for interlocking. They include the following forms:—(*a*) long stout spindles, slightly curved; (*b*) spindles expanding at one end in a pseudo-club fashion; (*c*) a few large triradiates; (*d*) numerous irregular triradiates; (*e*) smaller triradiates with a rough boss rising at right angles to the rays; (*f*) long-armed quadriradiates; (*g*) knobbed spherical "astroscleres."

The spicules of the cortex in general are spindles densely covered with relatively larger, rough-tipped, rounded tubercles. Especially on the shorter spindles do these tubercles stand out to a notable height like mammillæ, projecting to about one-fifth of the breadth of the spindle.

On the branches and twigs all the spicules are deep red, and there are numerous large spindles which tend to project on the surface in jagged fashion, being on the whole transversely disposed.

No spicules were to be found in the canal-walls.

The following measurements were taken:—

(*a*) Supporting-bundle spicules	Up to 2 mm.
(*b*) General upper-cortex spicules	Up to 4 mm.
(*c*) Largest spindles of the cortex of the sterile stalk	Up to 2 mm.

Locality:—Station 91. Macaras Reef in 27 fathoms.

10. **Dendronephthya klunzingeri** (Stud.).

Described by Studer in Ann. & Mag. Nat. Hist. (6) vol. i. p. 72.

Diagnosis:—Divaricate; contour discontinuous; polyps 10–12 in each bundle, which resembles a close corymb; polyp stalks very short; supporting bundle strong; point spicules 8–10 close together, none projecting; no crown; grade II.; spicules: in the stem loosely disposed slender spindles minutely spinulose, in the cortex of the sterile stalk spindles are more thorny and include triradiates and quadriradiates; colour: white on the whole, but with red-yellow twigs and polyp stalks.

Anthocodial Grade and Formula:—

II. = 8–10 p + 0 Cr + strong S.B.

Descriptive Notes:—

1. *Colony as a whole.* Markedly divaricate; contour discontinuous. A single, young colony.

2. *Branching.* Branches of varied lengths and growing in one plane. The colony therefore ought to be referred to Kükenthal's "B" section of the group Divaricatæ, and certainly in the neighbourhood of *D. klunzingeri*.

3. *Colouring.* Predominantly reddish yellow in the twigs and polyp stalks, elsewhere whitish.

4. *Polyp stalks* very short.

5. *Polyps.* Each bundle of polyps is rather like a close corymb and contains 10–12 heads. The tentacles are soft.

6. *Polyp spicules.* The anthocodial armature of 8–10 pairs of white spicules, closely opposed *en chevron* with no more than a hint of projection, is the salient feature of the colony. Owing to their white colour these spicules stand out very conspicuously. Their surface is covered irregularly with minute tubercles, which are much more crowded towards the tips.

The supporting bundle is strongly developed, its largest spicules projecting for 0·75 mm.

7. *Other spicules.* The stem has loosely disposed spindles, many of them having only minute and rather distant spinules. These tend to be slender. Those of the surface of the sterile stalk show a stronger development of thorns. There are, besides spindles, many irregular triradiates, quadriradiates, and brackets.

Text-fig. 17.

D. klunzingeri Stud.

Kükenthal lays stress on the great reduction of the sterile stalk. This is far from the case in this specimen, where it occupies 1·5 cm. out of a total height of 4 cm. From what I have seen in other cases, I do not think that the proportion of stalk to polyparium is of much importance.

Kükenthal also notes that the outermost polyps bore markedly projecting spicules at the tips of the points. Of this feature this specimen shows no more than a trace; but on account of the characteristic anthocodial armature, I cannot separate it from *D. klunzingeri.*

Locality:—Station 164 E.

11. **Dendronephthya microspiculata** (Pütter).

Described by Pütter, 'Alcyonaceen des Breslauer Museums' in Zool. Jahrb. xiii. Syst. pp. 459–460 (1900).

Diagnosis:—Divaricate; firm; long stalked: lowest branches slightly foliaceous; polyps in divergent groups of 4–10; polyp stalks long; supporting bundle strong; point spicules 6–8, small, close-set, the uppermost pair predominating and slightly projecting; no crown; grade II.; spicules: in the tentacles a double row of transversely arranged narrow, jagged, reddish spicules; in the cortex of the sterile stalk thick, bent, warty spindles and quadrangular bodies; colour: stalk, supporting bundle, polyp stalk, and tentacles a fine red; general cortex white flushed with red; anthocodial spicules white.

Anthocodial Grade and Formula:—

II. = I P + 5–7 p + 0 Cr + strong S.B.

Descriptive Notes:—

1. *Colony as a whole.* A somewhat firm young colony with

a long, limp stalk; total length 5 cm., of which 1·5 is polyparium.

2. *Branching.* The lowest branches show only hints of being foliaceous.

3. *Colour.* A fine coral-red in stalk, supporting bundle, polyp stalk, and tentacles; the general cortex of the polyparium is white flushed with red, and the anthocodial spicules are white.

Text-fig. 18.

D. microspiculata Pütter

4. *Polyp stalks* long.

5. *Polyps* in divergent groups of 4–10.

6. *Polyp spicules.* The armature of the anthocodiæ consists of 8 points of small spicules, very compactly disposed, 6–8 *en chevron* in each point; the uppermost pair in each row predominate and may project slightly.

The supporting bundle is strongly developed, and one strong central spindle projects for 1 mm.; the spicules here are thickly but finely spinose.

7. *Other spicules.* The tentacles show a double dorsal row of transversely disposed, narrow, jagged, reddish spicules; the cortex of the sterile stalk has thick spindles, usually bent, covered with large warts, often compound. Along with these are smaller bent spindles, often with large prongs on the convex side. There are also numerous bright red irregularly quadrangular or knob-like corpuscles, which may be vaguely called "stars." These are well figured by Pütter. All these stalk spicules with prongs are suited for interlocking.

Perhaps the most characteristic features are (1) the numerous compact chevron pairs of the anthocodial points, and (2) the quadrangular "stars."

Locality :—Station 315.

12. **Dendronephthya orientalis** (Hend.).

Described by Henderson in 'Alcyonarians of the Indian Ocean,' Part II. pp. 30–32 (1909).

Diagnosis :—Divaricate; no regular outline; somewhat flattened; polyps in loose clusters; polyp stalks long; supporting bundle strong; point spicules 1 pair only, of which one member is the larger and markedly projects; crown of 3 loose horizontal rows; grade VI.; spicules: tentacles conspicuously armoured, in the cortex very conspicuous strong spindles and numerous small warty triradiates and multiradiates; colour: general surface white, anthocodial and supporting-bundle spicules pink.

Anthocodial Grade and Formula :—

VI. = 1 P + 3 Cr + strong S.B.

Descriptive Notes :—

1. *Colony as a whole.* Divaricate ; without regular outline ; somewhat flattened ; with loose clusters of polyps ; agrees generally with Henderson's description. 4 colonies in all.

2. *Branching.* Short.

3. *Colour.* General surface white, with the spicules of the anthocodiæ and supporting bundles coral-pink.

4. *Polyp stalks.* Long.

5. *Polyps* in loose clusters of 6 or so.

6. *Polyp spicules.* The anthocodial 8 points consist of two curved spindles, one always larger than the other and projecting markedly beyond the polyp. The crown shows 3 rather loose horizontal rows, while below these and projecting outwards there are 8 stronger spindles approaching in size those of the points.

The supporting bundle is strongly developed, and consists of one very predominant spindle based in numerous small ones.

Text-fig. 19.

D. orientalis Hend.

7. *Other spicules.* On the aboral surface of the tentacles the armature is very conspicuous. Very characteristic in the cortex among the strong spindles are numerous small, irregular, warty spicules, often triradiate or with irregular rays in different directions. Among them are minute warty capstans like those figured by Henderson for the canal-walls.

Locality :—Station 125.

Another specimen with the same anthocodial armature, notably two unequal curved spindles rising in each point from a crown of 2–3 longitudinal rows, has a regular outline and only a slight hint of flattening. The spicules are coarsely tuberculate spindles and numerous irregular warty discs.

The spicules of the anthocodial and supporting bundles are amber-red and those of the general surface are golden yellow.

Locality :—Station. East of Polloe Weh.

III. UMBELLATÆ.

13. **Dendronephthya collaris** (Wr. & Stud.).

Described by Wright & Studer in Rep. Sc. Res. 'Challenger,' vol. xxxi. pp. 208–210 (1889).

Diagnosis.—Umbellate ; contour irregular ; basal branches foliaceous and form a collar ; polyps arranged in small roundish

masses: polyp stalks long; supporting bundle very strong; point spicules 5–6 with the uppermost pair stronger and projecting; no crown; grade IV.; spicules: very abundant spindles on the polyp stalks, of the polyps not on the collar sigmoid spindles, and of the collar irregular interlocking quadrangular "crosses"; colour: polyps of the foliaceous collar bright red, rest of the polyps white.

Anthocodial Grade and Formula:—

IV. = 5–6 p + 0 Cr + very strong S.B.

Descriptive Notes:—

1. *Colony as a whole.* Two colonies of which the larger measures, as regards the polyparium, 9·5 cm. high, 12 cm. broad, and 5 cm. in thickness.

2. *Branching.* Umbellate, referable to Kükenthal's section Umbellatæ, subsection with the umbels forming large hemispherical masses, and to the group *collaris*, where the contour is broken by the clefts between the masses. Quite divergent, however, in having only a short stalk, but this is probably only a growth condition related to the nature of the substratum. At the top of the short stalk the basal branches are foliaceous and form a collar.

3. *Colouring.* Polyps of the foliaceous collar are bright red; those of the rest of the colony white (not purple as in the 'Challenger,' specimen), but some of them show a tinge of red.

4. *Polyp stalks* are long.

5. *Polyps* arranged in small circular masses.

Text-fig. 20.

D. collaris Wr. & Stud.

6. *Polyp spicules.* The anthocodial armature shows 8 double rows of 5–6 converging pairs of spindles, and one at the top of each row may be much stronger than its neighbour and project beyond the polyp. These 8 projecting spines catch the eye at once.

The supporting bundle is very strong, with one spindle projecting far beyond the polyp.

7. *Other spicules.* The predominant spicules of the polyps not on the collar are spinulate slightly sigmoid spindles, the "f's" of the 'Challenger' description. The abundant spindles on the polyp stalks are almost *en chevron*. The characteristic spicules of the collar region are irregularly quadrangular bodies with very rough protuberances which secure interlocking. They correspond to what are called "crosses" by Wright and Studer. There are also spindles enlarged at one end into very rough clubs, curved spindles with very strong protuberances on the convex side, and irregular bodies like teeth with many roots.

Locality :—Station 99.

A second colony, the larger and flattened from side to side, may also be referred to *D. collaris*. Here the polyparium is very markedly transverse oval. There is no hint of any projection from the anthocodial points (which consists of 5–6 pairs *en chevron*), and the lower cortex shows, among other forms, numerous flattened, spindle-shaped, triradiate, boomerang-like, and irregular spicules, which have not been noticed in the other colonies studied. Very marked also are the length and strength of the prongs arising from some of the curved spindles, pseudo clubs, and irregular multiradiate bodies.

Deduction :—If one disregards the detail of growth on which Kükenthal partly bases the group *collaris*, namely that the hemispherical bunches are quite superficial, one should place *D. collaris* close beside *D. habereri*, which has more, though similar, spicules in its anthocodial points and a different kind of spiculation on the cortex of the sterile stalk.

14. **Dendronephthya longicaulis** (Kük.).

Described by Kükenthal in 'Versuch einer Revision der Alcyonarien,' ii. pp. 633–634 (1905).

Diagnosis :—Umbellate; very long stalked; somewhat flattened polyparium ; basal branches foliaceous and form a collar ; polyps in small, loose umbellate groups ; polyp stalks usually short, but may reach 2 mm. long ; supporting bundle weak ; point spicules one pair only, one of which is stronger; crown of 4–6 ; grade VI.; spicules : cortex of the branches covered with stout spindles bluntly tuberculate, cortex of the stalk with many stellate forms ; colour : general cortex has the surface pink-white, polyp-stalks red-brown, anthocodial spicules almost translucent.

Anthocodial Grade and Formula :—

VI. = I + 1 P + 4–6 Cr + weak S.B.

Descriptive Notes :—

1. *Colony as a whole.* A single, peculiar specimen unlike any other in the collection : marked by a long flexible stalk (10 cm. out of a total of 13) ; of uniform diameter (1·3 cm.) ; and bearing a rather loose umbellate polyparium, somewhat flattened.

2. *Branching.* The basal branches of the polyparium are foliaceous and form a collar turned downwards. There are but few branches extending transversely, so that the top of the polyparium appears rather truncate.

3. *Colouring.* General surface of the cortex is pinkish white, the polyp stalks reddish brown, while the anthocodial spicules are almost translucent.

4. *Polyp stalks* are on an average about 1 mm. long, but a length of 2 mm. may be attained. They appear to be bare on the ventral side.

5. *Polyps.* The bundles of polyps are disposed in small loose

umbellate groups. The upper part of the stalk, however, as Kükenthal describes, shows an incrustation of minute polyps.

6. *Polyp spicules.* The anthocodial armature conforms with Kükenthal's figure, but I should describe it somewhat differently, for it seems to me to have in each true point only one pair, one member of which is distinctly larger than the other, all the other (4–6) spicules being referable to the crown. Kükenthal describes two closely opposed spicules forming the upper part of the point, below 1–2 pairs of horizontals and below that again 3–4 converging pairs. On my view, however, each point consists of a pair of spicules.

Text-fig. 21.

D. longicaulis Kük.

The supporting bundle is very short, scarcely projecting.

7. *Other spicules.* The cortex of the branches is closely covered with strong spindles of typical shape and blunt tubercles—a feature in which this specimen does not conform to Kükenthal's description of *D. longicaulis*, where "the branch-cortex contains separate longitudinally disposed very narrow spindles with sharp thorns up to 2 mm. in length."

On the other hand, the cortex of the stalk shows a close array of stars as Kükenthal describes, and with the same average diameter of 0·1 mm. Among the stars are a few broad, short, densely tuberculate spindles.

Locality :—Station 310.

15. **Dendronephthya disciformis** (Kük.).

Described by Kükenthal in 'Versuch einer Revision der Alcyonarien,' ii. pp. 636–638 (1905).

Diagnosis :—Umbellate; compact; disc-like; outline uniform; polyps in bundles of 6–10; polyp stalks medium; supporting bundle very strong; point spicules about 5 pairs, with the uppermost larger spicule predominating and projecting; no crown; grade IV.; spicules: in the upper cortex long, curved spindles (2 mm.), in the lower cortex stout spindles, irregular stellate bodies for interlocking, and large triradiates and quadriradiates; colour: generally pink and orange, supporting bundles red.

Anthocodial Grade and Formula :—

IV. = I + 4 P + 0 Cr + very strong S.B.

Descriptive Notes :—

1. *Colony as a whole.* Six specimens. Each a compact colony of a generally uniform outline, with its umbels arranged in larger hemispherical masses which are superficially in contact, forming

a uniform outline. Below the surface are large spaces between the main branches, and some of these are tenanted by Decapod Crustaceans about 1·5 cm. in length. The colony is slightly disc-shaped, and has a very short, broad sterile stalk.

2. *Branching.* From the uniform outline and the arrangement of the umbels in large hemispherical masses, it should evidently be referred to Kükenthal's section Umbellatæ, first division, group *disciformis*.

3. *Colouring.* Generally of a pink and orange colour; the supporting bundle red.

4. *Polyp stalks* not over 1 mm. long.

5. *Polyps* in small bundles of 6–10.

6. *Polyp spicules.* In the anthocodial armature there are 4–5 pairs of converging spindles *en chevron* in each of the 8 points, and above these a much larger converging spindle rising almost 0·5 mm. beyond the polyp. In rare cases two spindles share in the projection, which is very characteristic. Below the points there is a vague crown, and there are 2–4 small intermediates between the points. All these spicules are whitish.

Text-fig. 22.

D. disciformis Kük.

In the supporting bundle about three very strong dark red densely spinose curved spindles project beyond the anthocodiæ, one being stronger than the others, and these are based in smaller but still strong spindles. The largest spindle measures 4 mm. in length, and shows a distinctly smooth tip (cf. *D. gigantea*).

7. *Other spicules.* The upper cortex is densely covered with long curved spindles, mostly in longitudinal arrangement, many of them 2 mm. in length. Some are red, some yellowish, while others are colourless. Only some of them show the distant fine spines that Kükenthal describes; most are covered somewhat densely.

The lower cortex shows (*a*) stout spindles with long conical tubercles; (*b*) very numerous small irregular stars with longish prongs, which may again be divided and are suited for interlocking; (*c*) large triradiates and quadriradiates covered with strong tubercles, sometimes massive and compound. A typical triradiate is about 1 mm. in maximum length, which is much larger than Kükenthal notes. But, of course, they occur in many sizes.

Salient features.—We should say that this species is best marked by (1) the strongly projecting 8 spindles at the tops of the points, (2) the strong red supporting bundle with its longest spindle smooth at the tip, and (3) the compact disc-like mode of growth in the full-grown colonies. It should also be noted that

there is considerable variety in the anthocodial points, especially with regard to the relation between the two terminal or the single terminal and the two or three rows immediately below.

Localities:—Stations 99, 164.

16. Dendronephthya habereri (Kük.).

Described by Kükenthal in 'Versuch einer Revision der Alcyonarien,' ii. pp. 638–641 (1905).

Diagnosis:—Umbellate; compact; stiff; almost uniform contour; polyparium very brittle; lowest branches foliaceous; polyps in small groups; polyp stalks very short; supporting bundle strong; point spicules over 7 pairs, short, not projecting; no crown; grade II.; spicules: lower cortex has very thick, rough spindles, triradiates, quadriradiates, and irregular bodies, all with compound tubercles suited for interlocking; colour: polyps yellowish, anthocodial armature opal-white, supporting bundle and upper cortex spicules pale pink, others whitish and colourless.

Anthocodial Grade and Formula:—

II. = 7 + p + 0 Cr + strong S.B.

Descriptive Notes:—

1. *Colony as a whole.* Eight colonies; umbellate; of very compact build, stiff; with a grouping of the umbels in hemispherical masses which, however, are so close together that an almost uniform contour results. The polyparium is 4·5 cm. in height, 7 cm. in width, and 4·5 cm. in thickness, in one instance, and is very brittle.

2. *Branching.* Nearer inspection shows that the colony is composed of about a dozen hemispherical masses rising from a short, broad, flattened stalk, with few short, thick branches, the lowest of which are foliaceous. It should therefore be referred to Kükenthal's group A, division 2, and to the *disciformis* group, where the polyparium is flattened and has an oval shape with the largest axis horizontal ("queroval"). Within this group the specimens agree with *D. habereri.* Although considerable portions of the short, broad stem and branches are bare, these are only seen on close examination, for the umbels, which all come to the surface, are practically continuous. The sterile stalk has its long axis in line with that of the polyparium.

3. *Colouring.* The polyps are yellowish, the anthocodial armature opal-white, the spicules of the supporting bundle and upper cortex are pale pink; the others are whitish and colourless.

4. *Polyp stalks* very short.

5. *Polyps* yellowish, in small groups.

6. *Polyp spicules.* The anthocodial armature consists of at least 7 pairs of converging short spindles in each point. These point spicules, which may not project, are about 0·2 mm in length,

and are densely covered with minute blunt cones. There is no distinct evidence of a crown.

The supporting bundle is strongly developed, and includes numerous curved spindles of various sizes up to 3·5 mm. in length. 3 or 4 spindles, often about 3 mm. long, make the apex of a bundle, and one is stronger than the others and projects beyond the polyp for over 0·5 mm. The other spindles of the supporting bundle are very much smaller. All show a very dense covering of high, blunt cones.

Text-fig. 23.

D. habereri Kük.

7. *Other spicules.* The lower cortex is densely packed with very thick, rough spindles, triradiates, quadriradiates, irregular bodies, and small, almost globular forms, with one particularly strong boss and numerous jagged points. The compound tubercles of all these spicules are well suited for interlocking. Some of the spindles are irregularly expanded at one end, and might be called club-like in a loose usage of that term.

Locality :—Station 258.

One specimen shows an undamaged sterile stalk, which has its long diameter in the same plane as the slightly flattened polyparium. The stalk is bright crimson, and shows very markedly a multitude of irregular, globular, slightly stellate small spicules which might perhaps be called "astroscleres."

Some of the anthocodial points show 8–10 rather irregularly converging pairs of rough spindles. There is no definite crown. The degree to which the supporting bundle projects varies considerably in different parts of the colony.

Locality :—Station 282.

Another colony, marked by a very short sterile stalk, a transverse oval mode of growth and little indication of foliate basal branches, shows an interesting colour variation which catches the eye at once. The 8 anthocodial points consist of 7 or more converging pairs of short spindles, but the upper half of each point has bright red spicules, while the lower half and the intermediates are white. In most of the polyps this contrast is very pronounced, but in some cases the red spicules predominate, and in other cases there is a slight mixture of the two colours.

Locality :—Station not marked.

17. **Dendronephthya pumilio** (Studer).

Described by Studer in Ann. Mag. Nat. Hist. (6) vol. i. pp. 70–71 (1888).

Diagnosis:—Umbellate; branches in rounded bunches closely packed; outline uniform; general shape flat to globose; polyps on the terminal twigs; polyp stalks long; supporting bundle very strong; point spicules about 5 pairs, the uppermost elongated; no crown; grade IV.; spicules: lower cortex has thick, bent, thorny spindles but no distinct stars; colour: generally yellowish white, polyps dark red, the tentacles densely crowded with minute rod-like reddish spicules.

Anthocodial Grade and Formula:—

IV. = I + 4 p + 0 Cr + very strong S.B.

Descriptive Notes:—

1. *Colony as a whole.* Four interesting specimens at different stages of growth, the largest having the following dimensions:—Total height 16 cm., height of sterile stalk 6·5 cm., breadth of polyparium 9·5 cm. The colony is very markedly umbellate in its largest forms, but less so in the younger forms, which tend to be much flattened.

2. *Branching.* The branches form rounded bunches, closely packed together and forming in the larger colonies a markedly uniform contour. The general shape varies from flat to globose, and I do not think that any importance can be attached to this.

3. *Colouring.* Yellow white, polyps dark red.

4. *Polyp stalks* long.

5. *Polyps* arranged on the terminal twigs.

6. *Polyp spicules.* The anthocodial armature is marked by the elongation of one or both of the terminal spicules of each point, the others, to the number of 2 or 3 pairs, being markedly subordinate. This is my grade IV. There is no crown.

The tentacles are long and heavily armoured, bearing dorsally a crowd, sometimes bilinear, of minute oval or rod-like reddish spicules.

Text-fig. 24.

D. pumilio Stud.

The supporting bundle is very strong, the largest spindle often projecting for 1 mm. The spicules are finely and thickly spinose, and often show smooth points. In many cases one polyp and its supporting bundle may be seen to predominate markedly over the others in the group.

7. *Other spicules.* The spicules of the lower cortex are mostly thick spindles, usually bent, and densely covered with strong,

blunt thorns, often compound. There are also numerous irregular bodies, but no distinct stars were seen.

Deduction :—I agree with Kükenthal in regarding *D. pumilio* as near to *D. spinosa* if not identical with it.

Localities :—Stations 99, 258, 315.

18. **Dendronephthya coronata** (Wr. & Stud.).

Described by Wright & Studer in Rep. Sc. Res. 'Challenger,' vol. xxxi. pp. 212–213 (1889).

Diagnosis :—Umbellate; polyps not grouped in small hemispherical heads; outline uniform; polyps in small loose bundles of 3–5; polyp stalks medium; supporting bundle very strong; point spicules 3–4, the upper pair markedly projecting; crown of three rows of roughly horizontal spindles; grade V.; spicules: cortex of the stem shows stout, thick spindles strongly tuberculate, also triradiates, quadriradiates, and irregular forms; colour: generally whitish, polyp spicules clear amber-yellow, supporting bundles strong purplish red.

Anthocodial Grade and Formula :—

V. = 3–4 p + 3 Cr + very strong S.B.

Descriptive Notes :—

1. *Colony as a whole.* Three colonies with polyps in distinct umbels, but not grouped in small hemispherical heads and forming as a whole a fairly uniform outline, agree in general with *D. coronata*, especially as revised by Kükenthal. They belong to his *florida* group of Umbellatæ, being slightly flattened in a longitudinal oval and showing a convex upper surface to the umbels.

2. *Branching.* The branches of the stem lead to the formation of large hemispherical masses of polyps.

3. *Colouring.* The general colour of the colonies is whitish, tending at the base to become red. One of the specimens showed a slightly different colour-scheme, having whitish instead of amber polyp spicules, but the same tendency to purplish red.

Text-fig. 25.

D. coronata Wr. & Stud.

4. *Polyp stalks* never attain a length of 2 mm.

5. *Polyps* in small, loose bundles of 3–5.

6. *Polyp spicules* are clear amber-yellow. The anthocodial armature shows 3–4 pairs of curved, thorny spindles *en chevron*, the upper pair markedly projecting over the base of the tentacles, below these is a crown of several rows of roughly horizontal spindles, and below these again are larger purplish spicules forming part of the supporting bundle.

This supporting bundle is very strong, and one spindle over 3 mm. in length projects for a distance of a little over 1 mm. beyond the polyp head; it is flanked basally on each side by one or more almost equally strong, and lateral to these are smaller spicules. All the spicules of the supporting bundle are strong purplish red.

One specimen showed frequently the occurrence of one projecting spicule at the tip of the points, or of two spicules markedly unequal. A search revealed, however, especially in the collar region, the typically equal pair characteristic of the species.

7. *Other spicules.* The cortex of the stem shows stout, thick spindles with strong tubercles, many markedly compound, truncated, and along with these there are triradiates and quadriradiates besides smaller exceedingly irregular warty bodies, often like the broken heads of clubs.

Locality:—Station not marked.

19. **Dendronephthya brevirama** (Burchardt).

Described by Burchardt in 'Alcyonaceen von Thursday-Island und von Amboina' in Semon, Forschungsreisen, V. 5; pp. 438–439 (1898).

Diagnosis:—Umbellate; umbels not combining in hemispherical masses; contour almost continuous; flattened in one plane; surface of the individual umbels varies from convex to concave; lowest branches slightly foliaceous and form an interrupted collar; polyps in small bundles; polyp stalks short; supporting bundle strong; point spicules 6–8: converging pairs of small spicules, none projecting; no crown; grade II.; spicules: cortex of branches shows long bright red spindles spinulose, cortex of stalk has coarsely tuberculate broad spindles, triradiates, and irregular discs: colour: general surface yellow-white, polyps yellow, branches with strong purplish spiculation.

Anthocodial Grade and Formula:—

II. = 6–8 p + 0 Cr + strong S.B.

Descriptive Notes:—

1. *Colony as a whole.* Six colonies, of which the largest measured 19 cm. in height by 13 cm. in width. The umbels do not combine in hemispherical masses; the contour of the polyparium is almost continuous; there is a considerable flattening in one plane; the surface of the individual umbels varies from convex to concave—a point to which I cannot attach importance. The specimen should be referred to Kükenthal's *florida* group and therein to within the species *D. brevirama.*

2. *Branching.* The lowest branches are slightly foliaceous, and form an interrupted collar.

3. *Colouring.* The general surface is yellow-white, the polyps yellow, the branches showing strong purplish spiculation.

4. *Polyp stalks* are short, a little less than 1 mm.

5. *Polyps* in small bundles.

6. *Polyp spicules.* The anthocodial armature of 8 points shows 6–8 converging pairs of small spicules, none projecting, and no very definite crown.

The supporting bundle has one strong spindle up to 3 mm. in length, predominating and projecting for about 0·75 mm.

Text-fig. 26.

D. brevirama Burch.

7. *Other spicules.* The cortex of the branches shows numerous long, straight, or curved bright red spindles, covered with short, rather delicate, sharply conical spinules, particularly crowded at the ends. The cortex of the stalk region shows (*a*) numerous coarsely tuberculate broad spindles, straight or curved; (*b*) asymmetrical bent spindles, with the tubercles stronger on the convex side; (*c*) spindles with one end broadened out; (*d*) irregular tuberculate discs, some almost spherical, others almost stellate; (*e*) regular and irregular triradiates (some very massive).

The canal-walls in the stalk region show numerous strong triradiates and curiously irregular quadriradiates, all roughly tuberculated, while besides these are minute irregularly radiate forms inclining to be smooth.

Locality :—Station not marked.

A much smaller younger colony, of which the polyparium measures 4 cm. by 4·6 cm., is worthy of notice because of certain slight divergences. The umbellate character of the twigs is much less pronounced, the whole branching is looser, the uppermost pair of spindles in each point sometimes projects to a very slight extent. These do not, however, differ from the others in the way characteristic of *D. coronata*, where the projection beyond the polyp is, of course, very marked. The specimen suggests that young stages of members of the Umbellatæ may present a somewhat Divaricate appearance.

On the other hand, the collection includes another colony, of which the polyparium measures 4·7 cm. by 4·7 cm. in maximum height and breadth, which is interesting in showing the very opposite vegetative characters; for it is markedly Umbellate in the branching of the twigs and extremely dense in the general branching, so presenting a uniform compact surface. Yet the spiculation and the anthocodial armature are identical. In the

recesses of the polyparium there lay a large Ophiuroid, with its arms extending in different directions and raising puzzling questions as to entrance and exit; for the whole surface of the polyparium is like a thick-set hedge without any gaps.

Locality:—Station 164.

Still another colony, at first sight divergent, agrees so thoroughly in anthocodial architecture and spiculation that separation appears to me impossible. The somewhat looser group of umbels show a marked tendency to grouping in hemispherical bunches, especially on one side of the colony; the contour is somewhat broken up; the lowest branches are slightly foliaceous; the sterile stalk has been broken off, leaving only a short stump; the general colouring is yellow-white, with white spindles in the polyps and faint rose tips to many of the supporting bundles. Yet an examination of the anthocodiæ shows the characteristic composition of the points, about 7 pairs of converging spicules, of which the uppermost pair may be slightly larger but do not project. Again, the lower cortex contains massive spindles with high compound warts, a few massive triradiates, many rough spindles curved at one end like a simple bugle, many pseudo-clubs, and very numerous small knobbed and bossed forms like astrospheres. In the canal-wall there are among rough types a number of characteristic, almost smooth, delicate, flat triradiates, quadriradiates, and approximate stars.

Deduction: — We have here another illustration of the inadvisability of attaching much importance to the vegetative characters.

In anthocodial architecture this species comes near *D. florida*, but the shortness of the polyp stalks is too emphatic to be neglected.

Locality:—Station 258.

20. **Dendronephthya annectens** (sp. n.). (Plate III.)

Diagnosis: — Umbellate; much branched, but few large branches; distinctly flattened; contour not uniform; basal branches foliaceous; polyps in small bundles of 7–12; polyp stalks very short; supporting bundle very weak; point spicules about 8 pairs, equal in size; crown absent; grade II.; spicules: short sterile stalk has irregularly branched, almost stellate, bodies; spindles of the branches often very large (6 mm.); colourless spindles in the general cortex and stars at the base; colour: exposed areas on the branches white; twigs have large orange and crimson spindles, supporting bundles either orange or crimson, polyp spicules white.

Anthocodial Grade and Formula:—

II. = 8 p + 0 Cr + very weak S.B.

Descriptive Notes:—

1. *Colony as a whole.* Very handsome umbellate colony with profuse root-work; hardly visible sterile stalk; much branched and, in its general aspect, distinctly flattened polyparium. It is 32 cm. in maximum height and 40 cm. in maximum breadth, with an approximate thickness of 6 cm. The contour of the whole colony is markedly interrupted.

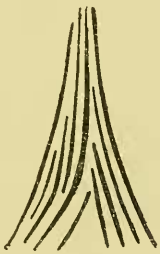
2. *Branching.* There is a general division into three strong branches each of which tends to lose the flattened aspect, broadening out into an exuberant corymbose head. The polyp-bearing twigs are distinct umbels. There are no definite large hemispherical bunches. Large areas on the branches are bare and exposed. The basal branches are foliaceous, but do not form a complete circle. The main branches give off numerous secondary and tertiary branches, which eventually break up in fairly regular dichotomy into minor corymbs which bring the crowded polyps more or less up to one level.

3. *Colouring.* The exposed areas on the branches are covered with irregularly scattered spindles, visible to the naked eye and giving the surface a glistening white appearance. On the twigs are large orange and crimson spindles, standing out conspicuously against the general white of the cortex. There seems to be no regularity in the distribution of the two colours, except that any one group of twigs is either orange or crimson. The supporting bundles are also either orange or crimson, but the polyp spicules are white.

Text-fig. 27.

D. annectens, sp. n.

Text-fig. 28.



D. annectens, sp. n., ensheathing type of supporting bundle: seen from below.

4. *Polyp stalks* are very short.

5. *Polyps.* The polyps themselves occur in small bundles of 7–12, and the stalk of each bundle is long.

6. *Polyp spicules.* The anthocodial armature consists of about 8 pairs of spicules *en chevron* on each of the eight points, all practically of the same size, about 0·13 mm. Below the point

there is no true crown, but there are small white spindles on the soft polyp stalk, lying irregularly but on the whole transversely and quite distinct from the coloured spindles of the supporting sheath which lie longitudinally. It is plain that the uppermost rows of these transverse spindles might furnish the raw materials of a crown.

The supporting bundle is of the ensheathing type and is often very inconspicuous. The typical form is a curved triangle around the polyp stalk, composed altogether of about a dozen spicules, and those composing the tip are not conspicuously longer than the rest. It is what might be called a slightly differentiated supporting sheath rather than a supporting bundle, and its comparatively small spindles must not be mixed up with the large supports of the common stalk of the common bundle. The supporting bundle only occasionally projects a little beyond the polyp. Its component spicules do not attain a length of more than 0·75 mm.

7. *Other spicules.* Very noteworthy is the spiculation of the short, sterile stalk, where for a very limited area the spindles are replaced by irregularly branched, almost stellate, bodies, which interlock and give the surface an arenaceous appearance. Many of the branchlet spindles are striking in their size, reaching a length of 6 mm. They are densely covered with truncated columnar tubercles which form regular curved transverse rows, recalling the septa of an elongated *Fungia* coral. The truncated tops are very rough and sometimes compound.

The colourless spindles of the general cortex are partly like small editions of those just mentioned, and partly narrower forms with distant and relatively few tubercles. They range from 1–2·5 mm. The small "stellate" forms at the base are very irregular in shape. Many are almost globular; many are minute quadriradiates; many show one predominant boss among the radiating knobs; while many again correspond exactly with those figured by Kükenthal for *D. japonica* (fig. L *b*)*.

Very few canal-wall spicules could be found. Those that occurred very sparingly were narrow rodlets with a few distinct tubercles.

Deduction:—Although this splendid specimen has no uniform contour it presents many resemblances to *D. brevirama* (Burch.), such as:

(1) the anthocodial armature of 6–8 spicules in each point, the uppermost not projecting;
(2) the short polyp stalk;
(3) the numerous 2 mm. spindles of the general cortex;
(4) the crowded stellate bodies of the lower cortex;
(5) in the polyp-bearing twigs a corymbose-dichotomous branching, almost identical with that of specimens which agree in detail with *D. brevirama*.

* Kükenthal, "Versuch einer Revision der Alcyonarien." Zool. Jahrbch. Jena. System. vol. xxi. p. 576.

Yet this specimen differs deeply from *D. brevirama* in the following respects:

(*a*) it has a different type of supporting bundle, namely a sheath, instead of showing one markedly predominating needle;

(*b*) it has practically no spicules in the canal-walls;

(*c*) it has not more than a hint of triradiates.

It therefore seems best to establish a new species, closely like *D. brevirama* (an Umbellate) in some respects and very like *D. japonica* (a Divaricate) in others.

Locality:—Station not marked.

21. **Dendronephthya simplex** (sp. n.).

Diagnosis:—Umbellate; compact; slightly flattened umbels not combined into large hemispherical masses; lower branches foliaceous; contour uniform; polyps compact; polyp stalks short; supporting bundle strong; point spicules, 2, long converging only; crown of some 3 rows of curved spindles; grade VI.; spicules: cortex has stout tuberculate spindles but no stars; colour: generally drab-yellow.

Anthocodial Grade and Formula:—

VI. = 1 or 2 P + 3 Cr + strong S.B.

Descriptive Notes:—

1. *Colony as a whole.* The entire colony is 9 cm. high, of which 2·5 cm. go to the sterile stalk. The breadth of the polyparium is 6 mm. The polyp-bearing twigs form small umbels, but these do not combine in larger hemispherical masses. The specimen should therefore be referred to Kükenthal's second group of the Umbellatæ and to the *florida* group, though the shape of the polyparium is rather circular than long oval. There is a uniform, very slightly interrupted contour to the whole colony, which has a somewhat flattened circular shape. The general appearance is compact. Practically the whole surface is covered by the polyps on their umbels, and no polyps occur except on the surface.

Text-fig. 29.

D. simplex, sp. n.

2. *Branching.* Some of the lower branches are foliaceous.

3. *Colouring.* On the whole the colour is drab-yellow.

4. *Polyp stalks.* Short.

5. *Polyps* in compact bundles of 10 or so, dense corymbs.

6. *Polyp spicules.* The anthocodial armature consists of 8 points of 2 long converging spindles each, and it may be said at

once that it is almost precisely that of *D. pütteri* (Divaricate) and not far from *D. lutea* (Umbellate, but with interrupted contour). The length of the point spicules is about 0·75 mm., but one is often slightly smaller than the other. Between the points there lies a pair of much smaller intermediates. At the base of the points there is a crown of about 3 rows of curved spindles, but some of these are often displaced so as to appear like the lower point spicules in *D. lutea*, in regard to which Kükenthal notes that an approach to a horizontal position sometimes occurs. This dislocation of what is really a horizontal band suggests the need of examining numerous polyps.

There is a strongly developed supporting bundle, the largest spicule of which, about 2 mm. in length, projects beyond the polyp for about 0·75 mm. It is abutted by two strong spindles on each side and by a number of smaller ones transitional to the polyp. The supporting-bundle spicules are slightly curved spindles, densely covered with relatively minute blunt and narrow cones. The spindles of the 8 points are similar, but show the characteristic hockey-club-like bend at the base.

7. *Other spicules.* All over the cortex there is a felting of more irregular and stouter spindles, often "f" shaped, with larger and often compound blunt tubercles. No stellate forms occur, but very numerous, quite irregular types are found which might be derived from spindles and club-like ends or from boomerangs. Their compound warts are often very strong and stronger on one side.

Locality :—Station not marked.

22. **Dendronephthya hyalina** (Kük.).

Described by Kükenthal in 'Versuch einer Revision der Alcyonarien,' ii. pp. 688–689 (1905).

Diagnosis :— Umbellate; flaccid; hyaline; umbels not in large hemispherical groups; outline not uniform; distinct foliaceous collar; polyps loosely aggregated; polyp stalks medium; supporting bundle strong; point spicules 4–5 pairs, without projection of the top pair; crown absent; grade III.; spicules: sterile stalk has numerous stellate and multiradiate forms; colour: cortex very hyaline, with loosely disposed white spicules.

Anthocodial Grade and Formula :—

III. = 4–5 p + 0 Cr + strong S.B.

Descriptive Notes :—

1. *Colony as a whole.* Eight young colonies, the largest of which measures 6·5 cm. high. They are very flaccid in texture and hyaline in appearance. The youngest forms show little hint of umbellate branching, but this is well marked in the biggest. As the umbels do not compose large hemispherical groups, the

specimens should be referred to section B of Kükenthal's Umbellatæ, and the presence of unequally long branches resulting in no very uniform outline points to the *spinulosa* group.

2. *Branching.* There is a distinct foliaceous collar.

3. *Colouring.* Cortex very hyaline and bearing loosely disposed white spicules.

4. *Polyp stalks.* Slightly over 1 mm. long.

5. *Polyps.* Few are in good condition, owing to the colonies having been much compressed in most cases; small groups of 3 or 4.

6. *Polyp spicules.* The anthocodial points consist of 4–5 pairs *en chevron*, with almost no projection of the uppermost pair and almost no crown.

Text-fig. 30.

D. hyalina Kük.

The supporting bundle is fairly well developed, and the strongest spicule may project for half a millimetre.

7. *Other spicules.* The sterile stalk shows numerous stellate and multiradiate spicules.

Localities :—Stations 257, 318, 321. Saleyer, 10–25 fms.

EXPLANATION OF THE PLATES.

Plate I. *Dendronephthya clavata* Kükenthal.

Plate II. *Dendronephthya gigantea* Verrill.

Plate III. *Dendronephthya annectens*, sp. n.